REMARKS

The present Amendment amends claims 34, 53, 61, and 62, and leaves claims 35-52 and 54-60 unchanged. Therefore, the present application has pending claims 34-62.

Interview Summary

Applicants thank the Examiner for granting the interview conducted on October 24, 2007. In the interview, arguments were presented to overcome the cited references, particularly Wark and Ochiai. The Examiner agreed that based on the sketch supplied by Applicants (Exhibit B), which outlines the distinguishing features between Wark and the present invention, Wark is different from the present invention. However, the Examiner indicated that a more detailed review of the Wark reference must be performed. The Examiner also agreed that the bumps of the present invention are different from the bumps disclosed in Figs. 1A, 1B and 12 of Wark. However, the Examiner disagreed that the bumps of the present invention are different from the bumps disclosed in Figs. 2A, 2B, 5A, 7A, and 7B of Wark. In the present response, Applicants reiterate the arguments presented during the interview.

35 U.S.C. §102 Rejections

Claims 34-36, 38, 42, 44, and 54-61 stand rejected under 35 U.S.C. §102(e) as being unpatentable over U.S. Patent Application Publication No. 2001/0054771 to Wark, et al. ("Wark"). Applicants submit that the features of the present invention as now more clearly recited in claims 34-36, 38, 42, 44 and 54-61 are not taught or suggested by Wark whether taken individually or in combination any of the other

references of record. Therefore, Applicants respectfully request the Examiner to reconsider and withdraw this rejection.

Amendments were made to the claims to more clearly describe features of the present invention. Specifically, amendments were made to the claims to more clearly recite that the present invention is directed to a method of producing a semiconductor device as recited, for example, in independent claims 34 and 61.

Claims 34-36, 38, 42, 44, and 54-60

The present invention, as recited in claim 34, provides a method of producing a semiconductor device, including the steps of forming a plurality of pyramid-shaped bump electrodes, and connecting the pyramid-shaped electrodes to pad electrodes of the semiconductor device. The step of forming the plurality of pyramid-shaped bump electrodes includes forming pyramid-shaped etched holes by anisotropically etching a base material having a crystal orientation, and filling up the etched pyramid-shaped holes by plating a metal to form the pyramid-shaped bump electrodes, where the shape of the pyramid-shaped bump electrodes is identical to the shape of the etched pyramid-shaped holes. The step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and transferring the pyramid-shaped bump electrodes to the pad electrodes. Also, according to the present invention, the pyramid-shaped bump itself is formed by a conductive material. Furthermore, according to the present invention, the pyramid-shaped bump electrodes have a shape of a pyramid, which is a figure having a square base

and four triangle-shaped sides that meet at a common point. The prior art does not disclose all these features.

The above described features of the present invention, as now more clearly recited in the claims, are not taught or suggested by any of the references of record, particularly Wark, whether taken individually or in combination with the other references of record.

Wark discloses a method for making projected contact structures for engaging bumped semiconductor devices. However, there is no teaching or suggestion in Wark of the method of producing a semiconductor device of the present invention, as recited in the claims.

Wark teaches a bumped semiconductor device contact structure including at least one non-planar contact pad having a plurality of projections extending from the contact pad. The projections contact at least one solder ball of a bumped integrated circuit (IC) device, such as a bumped die and a bumped packaged IC device. The projections are arranged to make electrical contact with the solder balls of a bumped IC device without substantially deforming the solder ball. Accordingly, reflow of solder balls to reform the solder balls is not necessary with the contact pad of Wark. Wark further discloses a method for forming the contact pads by etching a deposition.

One feature of the present invention, as recited in claim 34, includes where the step of forming the plurality of pyramid-shaped bump electrodes includes forming pyramid-shaped etched holes by anisotropically etching a base material having a crystal orientation, and filling up the etched pyramid-shaped holes by plating a metal

to form the pyramid-shaped bump electrodes, where the shape of the pyramid-shaped bump electrodes is identical to the shape of the etched pyramid-shaped holes. Wark does not disclose this feature.

To support the assertion that Wark teaches this feature, the Examiner cites paragraphs [0052], [0019] and [0059]. However, neither the cited text nor any other portion of Wark teaches the claimed features. For example, Wark does not teach or suggest forming pyramid-shaped etched holes as in the present invention.

To further illustrate features of the present invention, the Examiner's attention is directed to the sketch shown in ***Exhibit B***. As shown in the sketch, the present invention includes: (1) filling conductive material into pyramid-shaped holes formed by anisotropically etching a base material; (2) eliminating the base material; and (3) forming the bum electrode having a pyramid shape, where the shape of the bump is identical to a shape of the etched pyramid-shaped holes. By these steps of present invention, a semiconductor device can be manufactured in which dispersion in height is small and defective continuity will not occur while connecting with a substrate, thereby enabling mounting of a high density.

Contrary to the present invention, Wark discloses where a protrusion engages with a bump. As shown in the attached sketch of ***Exhibit B***, Wark teaches a method including steps of: eliminating a part of the substrate by way of anisotropically etching, and producing a conductive layer on the surface of the partially remained narrow protrusion. That is, the protrusion is made of the substrate itself. This is clear from the descriptions of "undercutting" at paragraph [0052], which is cited by the Examiner. Accordingly, contrary to the Examiner's assertions, Wark does not

teach or suggest a step of forming pyramid-shaped etched holes, as in the present invention.

Another feature of the present invention, as recited in claim 34, includes connecting the pyramid-shaped bump electrodes to pad electrodes of the semiconductor device, where the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and transferring the pyramid-shaped bump electrodes to the pad electrodes. Wark does not disclose this feature.

To support the assertion that Wark teaches this feature, the Examiner cites Figs. 1B, 2B, 3B, 4B, 5B, 6B, 7B, and 12. However, neither the cited figures nor any other portion of Wark teaches or suggest the claimed features.

For example, as exemplified by the sketch in the attached ***Exhibit B***, the present invention includes where the shape of the pyramid bump electrode is identical to a shape of the etched pyramid-shaped holes. Accordingly, in the present invention, the pyramid-shaped solder bump of which dispersion in height is small and defective continuity will not occur while connecting with the substrate, and also being superior of shape and positional precision. On the other hand, in Wark, as shown in the attached sketch, the conductive layer is formed after the protrusion is formed, as disclosed in paragraph [0059]. There is no teaching or suggestion in Wark of a step of connecting the pyramid-shaped bump electrodes to the pad electrode, as in the present invention. Furthermore, by the method of Wark, it becomes easier to invite dispersion in height. Accordingly, Wark is quite different from the present invention.

Yet another feature of the present invention, as recited in claim 34, includes forming a plurality of pyramid-shaped bump electrodes of the semiconductor device, where the pyramid-shaped bump electrodes have a shape of a pyramid, which is a figure having a square base and four triangle-shaped sides, and where the four triangle-shaped sides meet at a common point. Wark does not disclose this feature.

In the Office Action, the Examiner provided many different citations to a variety of drawings to support the assertion that Wark teaches a pyramid, as claimed. In the October 24, 2007 interview with the Examiner, Applicants' representative argued that the pyramid-shaped bump of the present invention is not the same as any of the bumps of Wark. The Examiner agreed that the bumps of the present invention are different from the bumps disclosed in Figs. 1A, 1B and 12 of Wark. However, the Examiner disagreed that the bumps of the present invention are different from the bumps disclosed in Figs. 2A, 2B, 5A, 7A and 7B of Wark.

Specifically, the Examiner asserted that items 42 and 48 of Figs. 2A and 2B are individual pyramids, which allegedly read on claim 34. The Examiner further asserted that item 134 of Fig. 5A is a pyramid, and allegedly reads on claim 34. Applicants disagree.

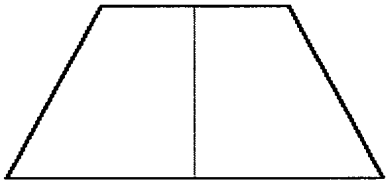
Preliminarily to the discussion of the pyramid shape of the present invention, the Examiner is reminded that the ordinary and customary meaning of a claim term is the meaning that the term would have to a person of ordinary skill in the art (MPEP 2111.01 (III)). (See definition of pyramid in ***Exhibit C*** (*Space Figures and Basic Solids*, available at www.mathleague.com). The definition cited by the Examiner (*Merriam Webster's Collegiate Dictionary*) is consistent with the definition of ***Exhibit***

C. In the alternative, Applicants remind the Examiner that an applicant may be his or her own lexicographer (MPEP 2111.01(IV)), and in the present invention, the pyramid-shaped bump electrodes have a shape of a pyramid, which is a figure having a square base and four triangle-shaped sides (claim 34).

As shown and as described on page 2 of the attached ***Exhibit A***, Fig. 2A and the accompanying text of Wark teaches where the contact structure 40 includes a plurality of knife-like projections 42, where the knife-like projections 42 are adjoined to form a frame-like receptacle for receiving a solder ball 44 therein between. Each projection 42 includes a pair of planar, sloping surfaces 46 and 48 that form a linear, ridge-like peak 50 (see Fig. 2B). Neither of the knife-like projections 42, the solder ball, or the contact structure 40 has a square base having triangular sides, to form a pyramid-shaped bump electrode, as claimed. Accordingly, contrary to the Examiner's assertions, items 42 and 48 are not individual pyramids.

As shown and as described on page 2 of the attached ***Exhibit A***, Fig. 2B and the accompanying text of Wark teaches where each projection 42 includes a pair of planar, sloping surfaces 46 and 48 that form a linear, ridge-like peak 50. The ridge-like peaks 50 define a square, and the blade-like projections 42 are spaced far enough away from the center of contact structure 40 such that each "slice" made by a projection 40 lies away from the center of the ball and is open at both ends. Neither the ridge-like peaks 50 nor the blade-like projections 42 has a square base having triangular sides, to form a pyramid-shaped bump electrode, as claimed. Accordingly, contrary to the Examiner's assertions, items 42 and 48 are not individual pyramids.

As shown and as described on page 3 of the attached ***Exhibit A***, Fig. 5A and the accompanying text of Wark teaches where a contact structure 130 includes a plurality of pyramidal projections 132 and 134 of rectangular transverse cross-section. The pyramidal projections 132 and 134 are not pyramids, as claimed. To the contrary, each pyramidal projection 132 and 134 has a rectangular base, a rectangular top, and 4 trapezoidal sides (i.e., isosceles trapezoids). The accompanying text of Fig. 5A does not describe the use of triangles in these projections. An isosceles trapezoid is shown below:



This isosceles trapezoid is not the same as a triangle, and accordingly, the trapezoid sides of Fig. 5a are not the same as the triangle sides of the present invention. Based on the disclosure of Wark, items 134 are merely a smaller version of items 132, which are clearly not pyramids, as claimed. Therefore, the bumps of Wark are quiet different from the present invention.

As shown and as described on page 4 of the attached ***Exhibit A***, Figs. 7A, 7B and the accompanying text of Wark teach where the contact structure 170 provides three levels of heights of knife-like or sharpened projections 172, 174 and 176 of trapezoidal, transverse cross-section. There is no teaching or suggestion that these projections 172, 174 and 176 have a square base and 4 triangle-shaped sides, thereby forming a pyramid, as in the present invention. In fact, as shown, the projections have at least one trapezoidal side, which is not the same as a triangle

side. Accordingly, the bump shown in Figs. 7A and 7B is not the same as the bumps of the present invention.

Therefore, Wark fails to teach or suggest "wherein said step of forming the plurality of pyramid-shaped bump electrodes includes: a step of forming pyramid-shaped etched holes by anisotropically etching a base material having a crystal orientation, and a step of filling up the etched pyramid-shaped holes by plating a metal to form the pyramid-shaped bump electrodes, wherein the shape of the pyramid-shaped bump electrodes is identical to a shape of the etched pyramid-shaped holes" as recited in claim 34.

Furthermore, Wark fails to teach or suggest "connecting the pyramid-shaped bump electrodes to pad electrodes of the semiconductor device" and "wherein the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes: a step of attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and a step of transferring the pyramid-shaped bump electrodes to the pad electrodes" as recited in claim 34.

Even further, Wark fails to teach or suggest "forming a plurality of pyramid-shaped bump electrodes of the semiconductor device" and "wherein the pyramid-shaped bump electrodes have a shape of a pyramid, which is a figure having a square base and four triangle-shaped sides, and wherein the four triangle-shaped sides meet at a common point" as recited in claim 34.

Claim 61

The present invention, as recited in claim 61, provides a method of producing a semiconductor device. The method includes a step of forming a plurality of

pyramidal bump electrodes of the semiconductor device. The method also includes a step of connecting the pyramidal bump electrodes to pad electrodes of the semiconductor device. According to the present invention, the step of forming the plurality of pyramidal bump electrodes includes a step of forming pyramidal etched holes by anisotropically etching a base material having a crystal orientation, and a step of filling up the etched pyramidal holes by plating a metal to form the pyramidal bump electrodes, where the shape of the pyramidal bump electrodes is identical to a shape of the etched pyramidal holes. Also according to the present invention, the step of connecting the pyramidal bump electrodes to the pad electrodes includes a step of attaching the base of the pyramidal bump electrodes to the pad electrodes, and a step of transferring the pyramidal bump electrodes to the pad electrodes. Furthermore, according to the present invention, the pyramidal bump electrodes are each formed by a conductive material, and the pyramidal bump electrodes have a shape of a figure comprising a rectangular base and at least two triangle-shaped sides. The prior art does not disclose all of these features.

The above described features of the present invention, as now more clearly recited in the claims, are not taught or suggested by any of the references of record, particularly Wark, whether taken individually or in combination with the other references of record.

As previously discussed, Wark discloses a method for making projected contact structures for engaging bumped semiconductor devices. However, there is no teaching or suggestion in Wark of the method of producing a semiconductor device of the present invention, as recited in the claims.

One feature of the present invention, as recited in claim 61, includes where the step of forming the plurality of pyramidal bump electrodes includes forming pyramidal etched holes by anisotropically etching a base material having a crystal orientation, and filling up the etched pyramidal holes by plating a metal to form the pyramidal bump electrodes, where the shape of the pyramidal bump electrodes is identical to the shape of the etched pyramidal holes. Wark does not disclose this feature.

To support the assertion that Wark teaches this feature, the Examiner cites paragraphs [0052], [0019] and [0059]. However, neither the cited text nor any other portion of Wark teaches the claimed features. For example, Wark does not teach or suggest forming pyramidal etched holes as in the present invention.

To further illustrate features of the present invention, the Examiner's attention is directed to the sketch shown in ***Exhibit B***. As shown in the sketch, the present invention includes: (1) filling conductive material into pyramidal holes formed by anisotropically etching a base material; (2) eliminating the base material; and (3) forming the bum electrode having a pyramid shape, where the shape of the bump is identical to a shape of the etched pyramidal holes. By these steps of present invention, a semiconductor device can be manufactured in which dispersion in height is small and defective continuity will not occur while connecting with a substrate, thereby enabling mounting of a high density.

Contrary to the present invention, Wark discloses where a protrusion engages with a bump. As shown in the attached sketch of ***Exhibit B***, Wark teaches a method including steps of: eliminating a part of the substrate by way of anisotropically

etching, and producing a conductive layer on the surface of the partially remained narrow protrusion. That is, the protrusion is made of the substrate itself. This is clear from the descriptions of "undercutting" at paragraph [0052], which is cited by the Examiner. Accordingly, contrary to the Examiner's assertions, Wark does not teach or suggest a step of forming pyramidal etched holes, as in the present invention.

Another feature of the present invention, as recited in claim 61, includes connecting the pyramidal bump electrodes to pad electrodes of the semiconductor device, where the step of connecting the pyramidal bump electrodes to the pad electrodes includes attaching the base of the pyramidal bump electrodes to the pad electrodes, and transferring the pyramidal bump electrodes to the pad electrodes. Wark does not disclose this feature.

To support the assertion that Wark teaches this feature, the Examiner cites Figs. 1B, 2B, 3B, 4B, 5B, 6B, 7B, and 12. However, neither the cited figures nor any other portion of Wark teaches or suggest the claimed features.

For example, as exemplified by the sketch in the attached ***Exhibit B***, the present invention includes where the shape of the pyramid bump electrode is identical to a shape of the etched pyramidal holes. Accordingly, in the present invention, the pyramidal solder bump of which dispersion in height is small and defective continuity will not occur while connecting with the substrate, and also being superior of shape and positional precision. On the other hand, in Wark, as shown in the attached sketch, the conductive layer is formed after the protrusion is formed, as disclosed in paragraph [0059]. There is no teaching or suggestion in Wark of a step

of connecting the pyramidal bump electrodes to the pad electrode, as in the present invention. Furthermore, by the method of Wark, it becomes easier to invite dispersion in height. Accordingly, Wark is quite different from the present invention.

Therefore, Wark fails to teach or suggest "wherein said step of forming the plurality of pyramidal bump electrodes includes: a step of forming pyramidal etched holes by anisotropically etching a base material having a crystal orientation, and a step of filling up the etched pyramidal holes by plating a metal to form the pyramidal bump electrodes, wherein the shape of the pyramidal bump electrodes is identical to a shape of the etched pyramidal holes" as recited in claim 61.

Furthermore, Wark fails to teach or suggest "connecting the pyramidal bump electrodes to pad electrodes of the semiconductor device" and "wherein the step of connecting the pyramidal bump electrodes to the pad electrodes includes: a step of attaching the base of the pyramidal bump electrodes to the pad electrodes, and a step of transferring the pyramidal bump electrodes to the pad electrodes" as recited in claim 61.

Therefore, Wark does not teach or suggest the features of the present invention, as recited in claims 34-36, 38, 42, 44, and 54-61. Accordingly, reconsideration and withdrawal of the 35 U.S.C. §102(e) rejection of claims 34-36, 38, 42, 44, and 54-61 as being anticipated by Wark are respectfully requested.

35 U.S.C. §103 Rejections

Claims 37, 39-41, 43, 45-53 and 62 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Wark in view of U. S. Patent No. 5,643,831 to Ochiai et al. ("Ochiai").

Claims 37, 39-41, 43, and 45-52 are dependent on claim 34. Therefore, claims 37, 39-41, 43, and 45-52 are allowable for at least the same reasons previously discussed regarding independent claim 34. Therefore, Applicants respectfully request the Examiner to reconsider and withdraw this rejection.

Regarding the remaining claims 53 and 62, this rejection is traversed for the following reasons. Applicants submit that the features of the present invention, as now more clearly recited in claims 53 and 62, are not taught or suggested by Wark or Ochiai, whether taken individually or in combination with each other in the manner suggested by the Examiner. Therefore, Applicants respectfully request the Examiner to reconsider and withdraw this rejection.

Amendments were made to the claims to more clearly describe features of the present invention. Specifically, amendments were made to the claims to more clearly recite that the present invention is directed to a method of producing a semiconductor device as recited, for example, in independent claims 53 and 62.

Claim 53

The present invention, as recited in claim 53, provides a method of producing a semiconductor device including forming a plurality of pyramid-shaped bump electrodes and connecting the pyramid-shaped bump electrodes to pad electrodes of the semiconductor device. The step of forming the plurality of pyramid-shaped electrodes includes forming a first pattern having openings at positions corresponding to etched holes by etching a first oxidized film formed on a surface of abase material having a crystal orientation, and forming the etched holes by using the first pattern as a mask. The step of forming the plurality of pyramid-shaped

electrodes further includes removing the first oxidized film and forming a second oxidized film anew on the etched holes. Also includes in the step of forming the plurality of pyramid-shaped electrodes is a step of forming a plated feeding film on the base material having the crystal orientation and on a side surface of each of the etched holes. The step of forming the pyramid-shaped electrodes also includes forming a second pattern of an organic material on the base material having the crystal orientation, so that the etched holes are not covered, and filling up the etched holes by plating a metal film on the plated film on the plated feeding film, where a shape of the pyramid-shaped bump electrodes is identical to a shape of the etched holes. The step of forming the pyramid-shaped electrodes further includes forming a gold plated film on the metal film and removing the second pattern of the organic material. The method of the present invention also includes where the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and transferring the pyramid-shaped bump electrodes to the pad electrodes. According to the present invention, the pyramid-shaped bump electrodes are each formed by a conductive material. Also according to the present invention, the pyramid-shaped bump electrodes have a shape of a pyramid, which is a figure having a square base and four triangle-shaped sides. Furthermore, according to the present invention, the four triangle-shaped sides meet at a common point. The prior art does not disclose all these features.

The above described features of the present invention, as now more clearly recited in the claims, are not taught or suggested by any of the references of record.

Specifically, the features are not taught or suggested by either Wark or Ochiai, whether taken individually or in combination with each other.

As previously discussed, Wark discloses a method for making projected contact structures for engaging bumped semiconductor devices. However, there is no teaching or suggestion in Wark of the method of producing a semiconductor device of the present invention, as recited in the claims.

One feature of the present invention, as recited in claim 53, includes forming a plurality of pyramid-shaped bump electrodes. As previously discussed with regard to the rejection of claim 34, and with reference to the attached ***Exhibit A***, Wark does not disclose the use of pyramid-shaped bump electrodes. To the contrary, and as shown, for example, in Fig. 1A (item 24), Fig. 2B (item 48) and Fig. 12 (item 510), Wark discloses the use of tetrahedron-shaped projections. These tetrahedron-shaped projections are not the same as the pyramid-shaped bump electrodes of the present invention.

Another feature of the present invention, as recited in claim 53, includes filling up the etched holes by plating a metal film on the plated film on the plated feeding film, where a shape of the pyramid-shaped bump electrodes is identical to a shape of the etched holes. Wark does not disclose this feature.

As previously discussed, and with reference to the attached ***Exhibit B***, the present invention includes: (1) filling conductive material into pyramid-shaped holes formed by anisotropically etching a base material; (2) eliminating the base material; and (3) forming the bum electrode having a pyramid shape, where the shape of the bump is identical to a shape of the etched pyramid-shaped holes. By these steps of

present invention, a semiconductor device can be manufactured in which dispersion in height is small and defective continuity will not occur while connecting with a substrate, thereby enabling mounting of a high density.

Contrary to the present invention, Wark discloses where a protrusion engages with a bump. As shown in the attached sketch of ***Exhibit B***, Wark teaches a method including steps of: eliminating a part of the substrate by way of anisotropically etching, and producing a conductive layer on the surface of the partially remained narrow protrusion. That is, the protrusion is made of the substrate itself. This is clear from the descriptions of "undercutting" at paragraph [0052], which is cited by the Examiner. Accordingly, contrary to the Examiner's assertions, Wark does not teach or suggest a step of forming pyramid-shaped etched holes, as in the present invention.

Yet another feature of the present invention, as recited in claim 53, includes where the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and transferring the pyramid-shaped bump electrodes to the pad electrodes. Wark does not disclose this feature.

As previously discussed, and with reference to the attached ***Exhibit B***, the present invention includes where the shape of the pyramid bump electrode is identical to a shape of the etched pyramid-shaped holes. Accordingly, in the present invention, the pyramid-shaped solder bump of which dispersion in height is small and defective continuity will not occur while connecting with the substrate, and also being superior of shape and positional precision. On the other hand, in Wark, as shown in

the attached sketch, the conductive layer is formed after the protrusion is formed, as disclosed in paragraph [0059]. There is no teaching or suggestion in Wark of a step of connecting the pyramid-shaped bump electrodes to the pad electrode, as in the present invention. Furthermore, by the method of Wark, it becomes easier to invite dispersion in height. Accordingly, Wark is quite different from the present invention.

Therefore, Wark fails to teach or suggest "forming a plurality of pyramid-shaped bump electrodes of the semiconductor device" as recited in claim 53.

Furthermore, Wark fails to teach or suggest "a step of filling up the etched holes by plating a metal film on the plated film on the plated feeding film, wherein a shape of the pyramidal bump electrodes is identical to a shape of the etched holes" as recited in claim 53.

Even further, Wark fails to teach or suggest "wherein the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes: a step of attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and a step of transferring the pyramid-shaped bump electrodes to the pad electrodes" as recited in claim 53.

The above noted deficiencies of Wark are not supplied by any of the other references of record, namely Ochiai, whether taken individually or in combination with each other. Therefore, combining the teachings of Wark and Ochiai in the manner suggested by the Examiner still fails to teach or suggest the features of the present invention as now more clearly recited in the claims.

Ochiai discloses a process for forming solder balls on a plate having apertures using solder paste and transferring the solder balls to the semiconductor

device. However, there is no teaching or suggestion in Ochiai of the method of producing a semiconductor device of the present invention, as recited in claim 53.

In Ochiai's method, a semiconductor is fabricated using a solder ball forming plate having cavities. The plate is made from a silicon plate having a flat surface in a crystallographic plane, and an orientation flat in a crystallographic plane. The cavities are formed on the flat surface of the plate by etching, using a mask having openings in the shape of a rhombus, arranged such that one side of the rhombus is generally parallel to the crystallographic plane. As a result, the cavities having a wedge-shaped bottom are formed. The cavities are then filled with a solder paste and are heated to from solder balls in the cavities while the plate is in an inclined position. The solder balls are then transferred from the plate to the semiconductor chip.

One feature of the present invention, as recited in claim 53, includes forming a plurality of pyramid-shaped bump electrodes. Ochiai does not disclose the use of pyramid-shaped bump electrodes, and the Examiner does not rely upon Ochiai for teaching this feature. Furthermore, Ochia teaches the formation of a portion by anisotropically etching silicon, and by heat melting filled solder pasted in the portion to form a solder bump. However, the final produced solder bump is half-sphere shaped, which is quite different from the present invention.

Another feature of the present invention, as recited in claim 53, includes filling up the etched holes by plating a metal film on the plated film on the plated feeding film, where a shape of the pyramid-shaped bump electrodes is identical to a shape of the etched holes. Ochiai does not disclose this feature. As previously discussed,

Ochiai does not teach the use of pyramid-shaped bump electrodes. Therefore, it follows that Ochiai does not teach or suggest where a shape of the pyramid-shaped bump electrodes is identical to a shape of the etched holes, as in the present invention.

Yet another feature of the present invention, as recited in claim 53, includes where the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and transferring the pyramid-shaped bump electrodes to the pad electrodes. Ochiai does not disclose this feature, and the Examiner does not rely upon Ochiai for teaching this feature. Furthermore, as previously discussed, Ochiai does not teach or suggest the formation of pyramid-shaped bump electrodes, as in the present invention. Therefore, Ochiai does not teach or suggest connecting pyramid-shaped bump electrodes to pad electrodes, in the manner claimed.

Therefore, Ochiai fails to teach or suggest "forming a plurality of pyramid-shaped bump electrodes of the semiconductor device" as recited in claim 53.

Furthermore, Ochiai fails to teach or suggest "a step of filling up the etched holes by plating a metal film on the plated film on the plated feeding film, wherein a shape of the pyramidal bump electrodes is identical to a shape of the etched holes" as recited in claim 53.

Even further, Ochiai fails to teach or suggest "wherein the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes: a step of attaching the base of the pyramid-shaped bump electrodes to the pad electrodes,

and a step of transferring the pyramid-shaped bump electrodes to the pad electrodes" as recited in claim 53.

Claim 62

The present invention, as recited in claim 62, provides a method of producing a semiconductor device including forming a plurality of pyramidal bump electrodes and connecting the pyramidal bump electrodes to pad electrodes of the semiconductor device. The step of forming the plurality of pyramidal electrodes includes forming a first pattern having openings at positions corresponding to etched holes by etching a first oxidized film formed on a surface of abase material having a crystal orientation, and forming the etched holes by using the first pattern as a mask. The step of forming the plurality of pyramidal electrodes further includes removing the first oxidized film and forming a second oxidized film anew on the etched holes. Also includes in the step of forming the plurality of pyramidal electrodes is a step of forming a plated feeding film on the base material having the crystal orientation and on a side surface of each of the etched holes. The step of forming the pyramidal electrodes also includes forming a second pattern of an organic material on the base material having the crystal orientation, so that the etched holes are not covered, and filling up the etched holes by plating a metal film on the plated film on the plated feeding film, where a shape of the pyramidal bump electrodes is identical to a shape of the etched holes. The step of forming the pyramidal electrodes further includes forming a gold plated film on the metal film and removing the second pattern of the organic material. The method of the present invention also includes where the step

of connecting the pyramidal bump electrodes to the pad electrodes includes attaching the base of the pyramidal bump electrodes to the pad electrodes, and transferring the pyramidal bump electrodes to the pad electrodes. According to the present invention, the pyramidal bump electrodes are each formed by a conductive material. Also according to the present invention, the pyramidal bump electrodes have a shape of a figure comprising a rectangular base and at least two triangle-shaped sides. The prior art does not disclose all these features.

The above described features of the present invention, as now more clearly recited in the claims, are not taught or suggested by any of the references of record. Specifically, the features are not taught or suggested by either Wark or Ochiai, whether taken individually or in combination with each other.

As previously discussed, Wark discloses a method for making projected contact structures for engaging bumped semiconductor devices. However, there is no teaching or suggestion in Wark of the method of producing a semiconductor device of the present invention, as recited in the claims.

One feature of the present invention, as recited in claim 62, includes forming a plurality of pyramidal bump electrodes. As previously discussed with regard to the rejection of claim 34, and with reference to the attached ***Exhibit A***, Wark does not disclose the use of pyramidal bump electrodes. To the contrary, and as shown, for example, in Fig. 1A (item 24), Fig. 2B (item 48) and Fig. 12 (item 510), Wark discloses the use of tetrahedron-shaped projections. These tetrahedron-shaped projections are not the same as the pyramidal bump electrodes of the present invention.

Another feature of the present invention, as recited in claim 62, includes filling up the etched holes by plating a metal film on the plated film on the plated feeding film, where a shape of the pyramidal bump electrodes is identical to a shape of the etched holes. Wark does not disclose this feature.

As previously discussed, and with reference to the attached ***Exhibit B***, the present invention includes: (1) filling conductive material into pyramidal holes formed by anisotropically etching a base material; (2) eliminating the base material; and (3) forming the bum electrode having a pyramid shape, where the shape of the bump is identical to a shape of the etched pyramidal holes. By these steps of present invention, a semiconductor device can be manufactured in which dispersion in height is small and defective continuity will not occur while connecting with a substrate, thereby enabling mounting of a high density.

Contrary to the present invention, Wark discloses where a protrusion engages with a bump. As shown in the attached sketch of ***Exhibit B***, Wark teaches a method including steps of: eliminating a part of the substrate by way of anisotropically etching, and producing a conductive layer on the surface of the partially remained narrow protrusion. That is, the protrusion is made of the substrate itself. This is clear from the descriptions of "undercutting" at paragraph [0052], which is cited by the Examiner. Accordingly, contrary to the Examiner's assertions, Wark does not teach or suggest a step of forming pyramidal etched holes, as in the present invention.

Yet another feature of the present invention, as recited in claim 62, includes where the step of connecting the pyramidal bump electrodes to the pad electrodes

includes attaching the base of the pyramidal bump electrodes to the pad electrodes, and transferring the pyramidal bump electrodes to the pad electrodes. Wark does not disclose this feature.

As previously discussed, and with reference to the attached ***Exhibit B***, the present invention includes where the shape of the pyramid bump electrode is identical to a shape of the etched pyramidal holes. Accordingly, in the present invention, the pyramidal solder bump of which dispersion in height is small and defective continuity will not occur while connecting with the substrate, and also being superior of shape and positional precision. On the other hand, in Wark, as shown in the attached sketch, the conductive layer is formed after the protrusion is formed, as disclosed in paragraph [0059]. There is no teaching or suggestion in Wark of a step of connecting the pyramidal bump electrodes to the pad electrode, as in the present invention. Furthermore, by the method of Wark, it becomes easier to invite dispersion in height. Accordingly, Wark is quite different from the present invention.

Therefore, Wark fails to teach or suggest "forming a plurality of pyramidal bump electrodes of the semiconductor device" as recited in claim 62.

Furthermore, Wark fails to teach or suggest "a step of filling up the etched holes by plating a metal film on the plated film on the plated feeding film, wherein a shape of the pyramidal bump electrodes is identical to a shape of the etched holes" as recited in claim 62.

Even further, Wark fails to teach or suggest "wherein the step of connecting the pyramidal bump electrodes to the pad electrodes includes: a step of attaching the base of the pyramidal bump electrodes to the pad electrodes, and a step of

transferring the pyramidal bump electrodes to the pad electrodes" as recited in claim 62.

The above noted deficiencies of Wark are not supplied by any of the other references of record, namely Ochiai, whether taken individually or in combination with each other. Therefore, combining the teachings of Wark and Ochiai in the manner suggested by the Examiner still fails to teach or suggest the features of the present invention as now more clearly recited in the claims.

Ochiai discloses a process for forming solder balls on a plate having apertures using solder paste and transferring the solder balls to the semiconductor device. However, there is no teaching or suggestion in Ochiai of the method of producing a semiconductor device of the present invention, as recited in claim 62.

In Ochiai's method, a semiconductor is fabricated using a solder ball forming plate having cavities. The plate is made from a silicon plate having a flat surface in a crystallographic plane, and an orientation flat in a crystallographic plane. The cavities are formed on the flat surface of the plate by etching, using a mask having openings in the shape of a rhombus, arranged such that one side of the rhombus is generally parallel to the crystallographic plane. As a result, the cavities having a wedge-shaped bottom are formed. The cavities are then filled with a solder paste and are heated to from solder balls in the cavities while the plate is in an inclined position. The solder balls are then transferred from the plate to the semiconductor chip.

One feature of the present invention, as recited in claim 62, includes forming a plurality of pyramidal bump electrodes. Ochiai does not disclose the use of

pyramidal bump electrodes, and the Examiner does not rely upon Ochiai for teaching this feature. Furthermore, Ochia teaches the formation of a portion by anisotropically etching silicon, and by heat melting filled solder pasted in the portion to form a solder bump. However, the final produced solder bump is half-sphere shaped, which is quite different from the present invention.

Another feature of the present invention, as recited in claim 62, includes filling up the etched holes by plating a metal film on the plated film on the plated feeding film, where a shape of the pyramidal bump electrodes is identical to a shape of the etched holes. Ochiai does not disclose this feature. As previously discussed, Ochiai does not teach the use of pyramidal bump electrodes. Therefore, it follows that Ochiai does not teach or suggest where a shape of the pyramidal bump electrodes is identical to a shape of the etched holes, as in the present invention.

Yet another feature of the present invention, as recited in claim 62, includes where the step of connecting the pyramidal bump electrodes to the pad electrodes includes attaching the base of the pyramidal bump electrodes to the pad electrodes, and transferring the pyramidal bump electrodes to the pad electrodes. Ochiai does not disclose this feature, and the Examiner does not rely upon Ochiai for teaching this feature. Furthermore, as previously discussed, Ochiai does not teach or suggest the formation of pyramidal bump electrodes, as in the present invention. Therefore, Ochiai does not teach or suggest connecting pyramidal bump electrodes to pad electrodes, in the manner claimed.

Therefore, Ochiai fails to teach or suggest "forming a plurality of pyramidal bump electrodes of the semiconductor device" as recited in claim 62.

Furthermore, Ochiai fails to teach or suggest "a step of filling up the etched holes by plating a metal film on the plated film on the plated feeding film, wherein a shape of the pyramidal bump electrodes is identical to a shape of the etched holes" as recited in claim 62.

Even further, Ochiai fails to teach or suggest "wherein the step of connecting the pyramidal bump electrodes to the pad electrodes includes: a step of attaching the base of the pyramidal bump electrodes to the pad electrodes, and a step of transferring the pyramidal bump electrodes to the pad electrodes" as recited in claim 62.

Both Wark and Ochiai suffer from the same deficiencies, relative to the features of the present invention, as recited in the claims. Therefore, combining the teachings of Wark and Ochiai in the manner suggested by the Examiner does not render obvious the features of the present invention as now more clearly recited in the claims. Accordingly, reconsideration and withdrawal of the 35 U.S.C. §103(a) rejection of claims 37, 39-41, 43, 45-53, and 62 as being unpatentable over Wark in view of Ochiai are respectfully requested.

The remaining references of record have been studied. Applicants submit that they do not supply any of the deficiencies noted above with respect to the references used in the rejection of claims 34-62.

In view of the foregoing amendments and remarks, Applicants submit that claims 34-62 are in condition for allowance. Accordingly, early allowance of claims 34-62 is respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, or credit any overpayment of fees, to the deposit account of Mattingly, Stanger, Malur & Brundidge, P.C., Deposit Account No. 50-1417 (referencing Attorney Docket No. 500.38090X00).

Respectfully submitted,

MATTINGLY, STANGER, MALUR & BRUNDIDGE, P.C.

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Registration No. 45,962

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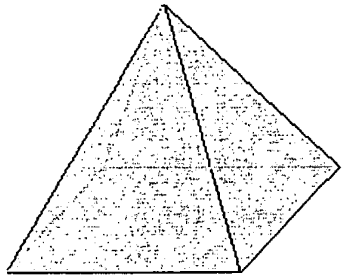
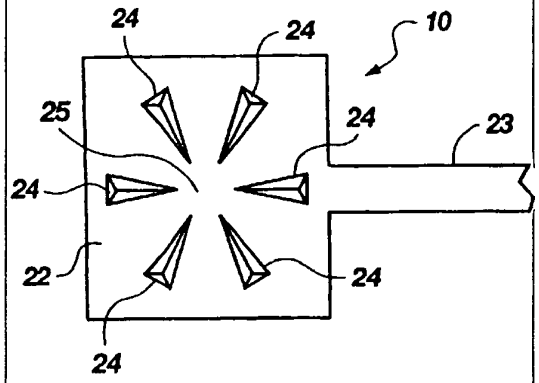
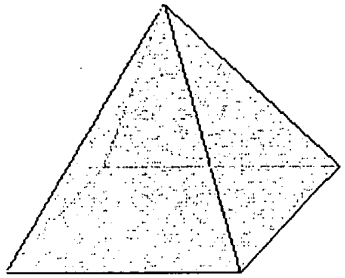
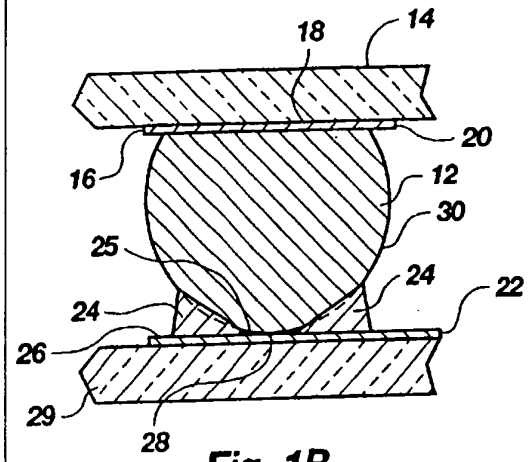
Pyramid: A pyramid has a square base and 4 triangle-shaped sides.	**Alleged Pyramids:** The Examiner relies upon each of the following figures for teaching a pyramid.	**Distinguishing Features:** Wark does not disclose a pyramid having a square base and 4 triangle-shaped sides.
	 Fig. 1A	The projections 24 are "triangular or pyramid-*like*" structures (see paragraph [0042]). Each has a triangle-shaped base and 3 other triangle-shaped sides. The projections 24 do not have a square base, as in the present invention. Therefore, the projections 24 are not pyramid-shaped according to the well-known definition of a pyramid.
	 Fig. 1B	As discussed above with regard to the related Fig. 1A, the projections 24 are merely "triangular or pyramid-*like*" structures. There is no teaching or suggestion in Wark of where the projections have a square base and 4 triangle-shaped sides as in the present invention.

<table>
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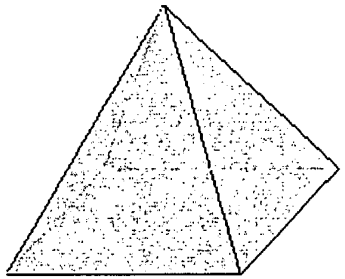
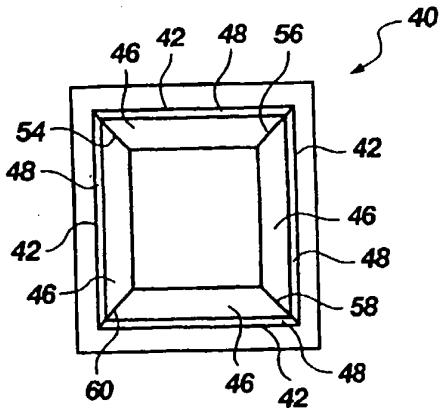
<td>  </td>
<td> 

Fig. 2A</td>
<td>The contact structure 40 includes a plurality of knife-like projections 42, where the knife-like projections 42 are adjoined to form a frame-like receptacle for receiving a solder ball 44 therein between. Each projection 42 includes a pair of planar, sloping surfaces 46 and 48 that form a linear, ridge-like peak 50 (see Fig. 2B). Neither of the knife-like projections 42, the solder ball, or the contact structure 40 has a square base having triangular sides, to form a pyramid-shaped bump electrode, as claimed.</td>
</tr>
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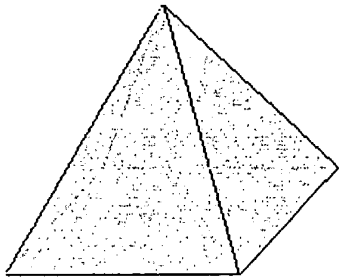
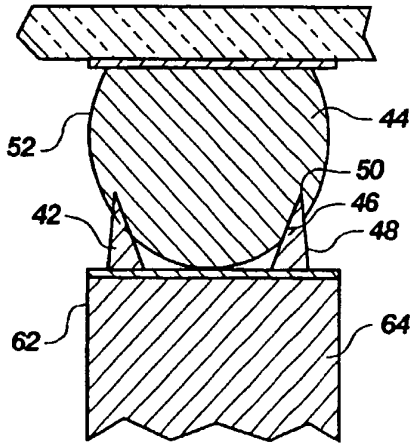
<td>  </td>
<td> 

Fig. 2B</td>
<td>Each projection 42 includes a pair of planar, sloping surfaces 46 and 48 that form a linear, ridge-like peak 50. The ridge-like peaks 50 define a square, and the blade-like projections 42 are spaced far enough away from the center of contact structure 40 such that each "slice" made by a projection 40 lies away from the center of the ball and is open at both ends. Neither the ridge-like peaks 50 nor the blade-like projections 42 has a square base having triangular sides, to form a pyramid-shaped bump electrode, as claimed.</td>
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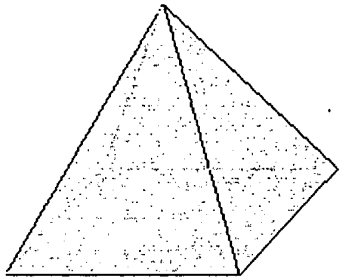
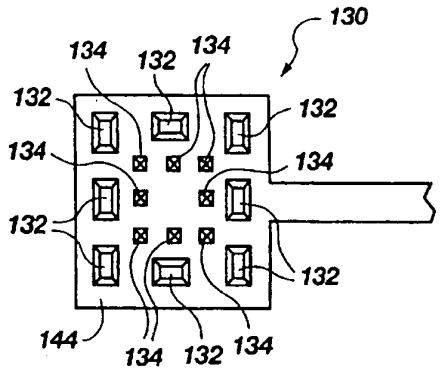
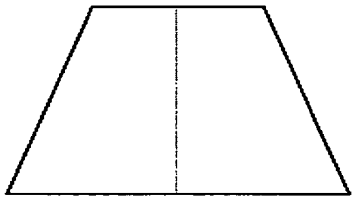
<td>  </td>
<td> 

Fig. 5A</td>
<td>A contact structure 130 includes a plurality of pyramidal projections 132 and 134 of rectangular transverse cross-section. The pyramidal projections 132 and 134 are not pyramids, as claimed. To the contrary, each pyramidal projection 132 and 134 has a rectangular base, a rectangular top, and 4 trapezoidal sides (i.e., isosceles trapezoids). There are no triangles in these projections. An isosceles trapezoid is shown below:
 
The trapezoid sides of Fig. 5a are not the same as the triangle sides of the present invention.</td>
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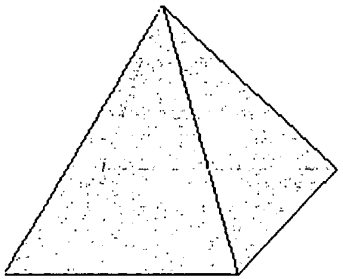
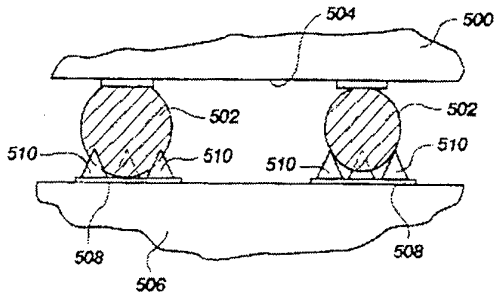
<td>  </td>
<td> 

Fig. 12</td>
<td>The contact pads 508 are aligned by projections 510. There is no teaching or suggestion that these projections 510 have a square base and 4 triangle-shaped sides, thereby forming a pyramid, as in the present invention.</td>
</tr>
</table>

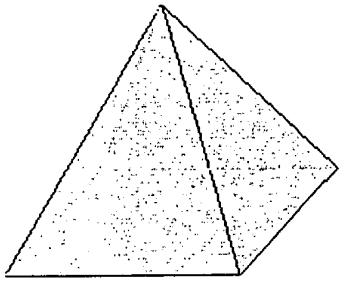
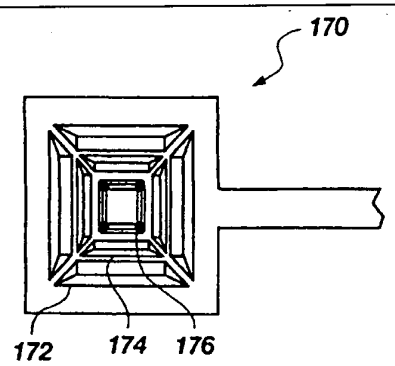
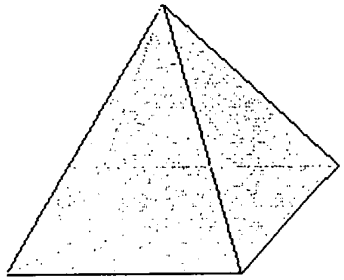
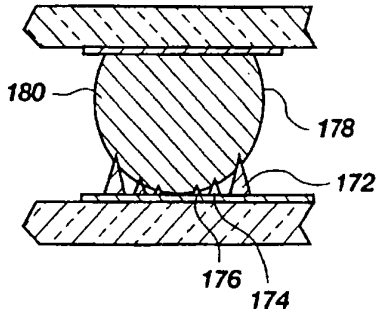
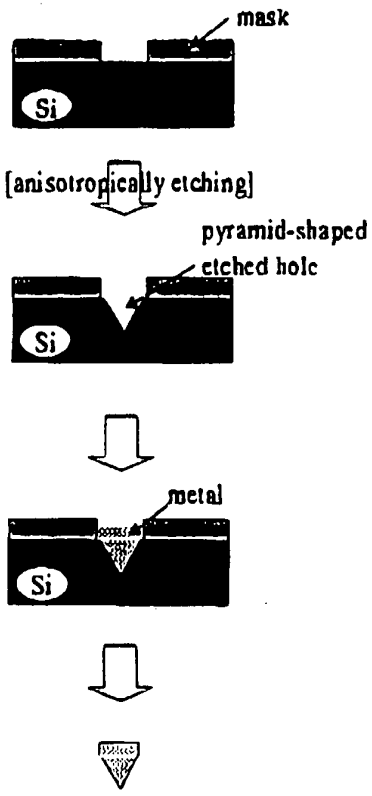
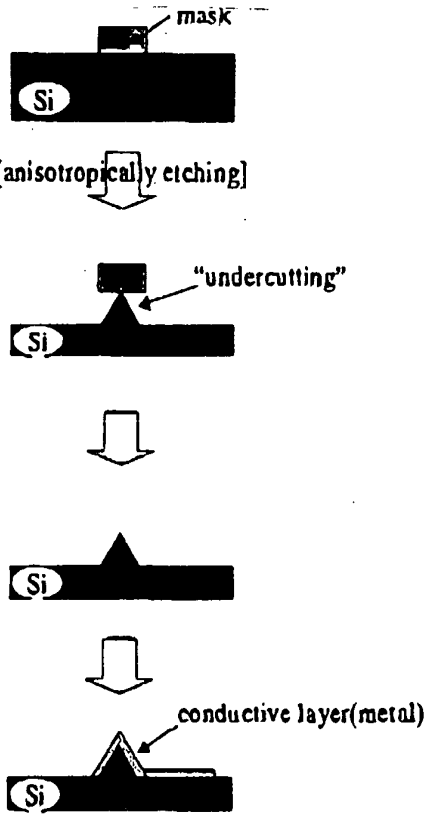
	 Fig. 7A	The contact structure 170 provides three levels of heights of knife-like or sharpened projections 172, 174 and 176 of trapezoidal, transverse cross-section. There is no teaching or suggestion that these projections 172, 174 and 176 have a square base and 4 triangle-shaped sides, thereby forming a pyramid, as in the present invention. In fact, as shown, the projections have at least one trapezoidal side, which is not the same as a triangle side.
	 Fig. 7B	The knife-like or sharpened projections 172, 174 and 176 are configured to engage the perimeter or outer surface 178 of a solder ball 180. There is no teaching or suggestion that these projections 172, 174 and 176, which are clearly shown in Fig. 7A, have a square base and 4 triangle-shaped sides, thereby forming a pyramid, as in the present invention.

EXHIBIT B

PRESENT INVENTION



WARK ET AL.



Wark.et.al

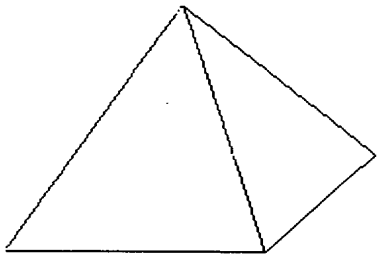
EXHIBIT C

Pyramid

A pyramid is a space figure with a square base and 4 triangle-shaped sides.

Example:

The picture below is a pyramid. The grayed lines are edges hidden from view.

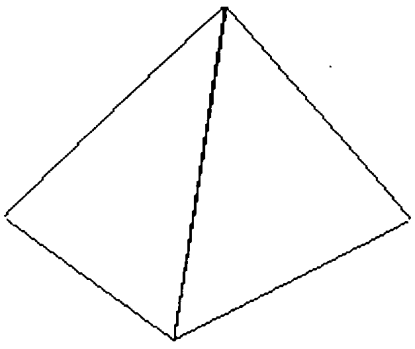


Tetrahedron

A tetrahedron is a 4-sided space figure. Each face of a tetrahedron is a triangle.

Example:

The picture below is a tetrahedron. The grayed lines are edges hidden from view.



Prism

A prism is a space figure with two congruent, parallel bases that are polygons.